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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/774,417	02/10/2004	Yoshiki Nishibayashi	50212-559	1031

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McDermott, Will & Emery  
600 13th Street, N.W.  
Washington, DC 20005-3096

EXAMINER
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OLSEN, ALLAN W

ART UNIT	PAPER NUMBER
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1763

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/05/2007	PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

## Office Action Summary

Application No.

10/774,417

Applicant(s)

NISHIBAYASHI ET AL.

Examiner

Allan Olsen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 25 October 2006.  
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1,3 and 4 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.  
5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.  
6) ☒ Claim(s) 1,3 and 4 is/are rejected.  
7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.  
10) ☒ The drawing(s) filed on 04 August 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☒ Certified copies of the priority documents have been received in Application No. 09/995,854.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)  
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 7/19/2006.  
4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_  
5) ☐ Notice of Informal Patent Application (PTO-152)  
6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on October 25, 2006 has been entered.

### ***Specification***

The disclosure is objected to because of the following informalities:

Page 25, lines 6-7, recites:

*"when N<sub>2</sub> gas is added to a mixed gas containing O<sub>2</sub> gas and N<sub>2</sub> gas."*

However, one of the two occurrences of "N<sub>2</sub>" should be CF<sub>4</sub>.

Appropriate correction is required.

### ***Drawings***

The drawings are objected to because in figure 10, the last six entries in column four should be --0.5--, not "5". Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must

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be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1, 3 and 4 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. Claim 1 contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. As is evident from the figures 4 and 5, the A/B ratio is dependent upon the particular wavelengths that are selected as being representative of A and B. Figure 6 is the only disclosure that pertains to the A/B ratio and the N<sub>2</sub> content. There is no disclosure regarding what specific wavelengths to use in determining the A/B ratio.

Claims 1, 3 and 4 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. Claim 1 contains subject matter which

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was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors, at the time the application was filed, had possession of the claimed invention. The only disclosure pertaining to the effect of N<sub>2</sub> on the O:O<sub>2</sub> ratio is when the other component of the plasma gas is a 99: 1 mixture of O<sub>2</sub> and CF<sub>4</sub>. Aside from the one example containing 1% CF<sub>4</sub>, there is no evidence, nor suggestion in the disclosure, that there is any particular amount of N<sub>2</sub> that would be responsible for bringing about the claimed inversion of the A/B ratio.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

**Claims 1, 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over the paper by Shiomi, "High-Rate Reactive Ion Etching of Diamond and Fabrication of Porous Diamond for Field-Emission Cathode", in New Diamond, Vol. 13, No 4. pp 28-29, in view of US Patent 6,261,726 issued to Brooks et al. and further in view of US Patent 6,013,191 issued to Nasser-Faili et al. (hereinafter, Shiomi, Brooks and Nasser-Faili, respectively).**

Shiomi teaches the reactive ion etching of a masked diamond surface. Shiomi teaches the mask comprises aluminum (page 2, line 17 of translation). Shiomi teaches that diamond is etched by a plasma of 100% O<sub>2</sub>. Shiomi teaches that the plasma may alternatively comprise NO<sub>2</sub> or N<sub>2</sub>. Shiomi teaches that the angle of the sidewall can be controlled by adding CF<sub>4</sub> to the etchant. Shiomi teaches that vertical sidewalls can be

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obtained by adding a very small amount of  $\text{CF}_4$ . Shiomi teaches using a  $\text{CF}_4$  concentration as low as 0.125% (page 5, line 2).

Shiomi does not teach supplying at least  $0.45 \text{ W/cm}^2$  of power to the RIE process. Shiomi does not teach using a both  $\text{O}_2$  and  $\text{N}_2$  in the plasma gas.

Brooks teaches etching diamond with a mixture of  $\text{O}_2$  and  $\text{N}_2$ . See column 6, line 63.

Nasser-Faili teaches applying  $1.5 \text{ W/cm}^2$  of power in an RIE process in which plasma comprising  $\text{O}_2$  and  $\text{NF}_3$  is used to etch diamond. See column 3, lines 42-48 and column 6, lines 23-25.

It would have been obvious to one skilled in the art to etch diamond with plasma comprising  $\text{O}_2$  and  $\text{N}_2$  and a fluorine-containing compound because Shiomi teaches using either  $\text{O}_2$  or  $\text{N}_2$  and "[i]t is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose."<sup>1</sup> Furthermore, an  $\text{O}_2$  plasma and an  $\text{O}_2/\text{N}_2$  plasma are art recognized equivalents with respect to the etching of diamond because Shiomi teaches etching diamond with an  $\text{O}_2$  plasma and Brooks teaches etching diamond with an  $\text{O}_2/\text{N}_2$  plasma.

It would be obvious to add the fluorine to the  $\text{O}_2/\text{N}_2$  mixture of Brooks to gain the control over the etching profile as taught by Shiomi. Additionally, in view of Nasser-Faili's teaching, the skilled artisan would have reasonable expectation of success because Nasser-Faili demonstrates the etching of diamond with plasma comprising

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oxygen, nitrogen and a low fluorine content. While plasma etching the diamond, it would have been obvious to one skilled in the art apply at least  $0.45 \text{ W/cm}^2$  because Nasser-Faili teaches that by supplying  $1.5 \text{ W/cm}^2$  of power, one can obtain vertical structures similar to those obtained taught by Shiomi.

Regarding the newly added limitation that requires providing a sufficient amount of nitrogen to the gas mixture so that a the ratio of the emission intensity of oxygen atoms to the emission intensity of molecular oxygen is greater than it would be in pure  $\text{O}_2$  plasma, the examiner notes the well-established principal that the ratio of atomic oxygen to molecular oxygen ( $\text{O}:\text{O}_2$ ) increases when fluorine is added to an oxygen plasma (See, for example, IBM Technical Disclosure Bulletin NN8712128). As such, using the gas mixture made obvious by Shiomi, Brooks and Nasser-Faili would result in a nitrogen containing plasma having the claimed inverted ratio between atomic and molecular oxygen.

### ***Response to Arguments***

Applicant's arguments filed October 25, 2006 have been fully considered but they are not persuasive.

Applicant's arguments focus on the issues of functional equivalence, the role of nitrogen in the claimed invention and the requisite motivation for combining references.

At the outset, "the Examiner is questioned as to the basis for the asserted functional equivalence of a mixture of 100% oxygen and a mixture of oxygen and

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<sup>1</sup> *In re Kerkhoven* 205 USPQ 1069 (CCPA 1980). Cites *In re Susi* 169 USPQ 423, 426 (CCPA 1971); *In re Crockett* 126 USPQ 186, 188 (CCPA 1960). See also *Ex parte Quadranti* 25 USPQ 2d 1071 (BPAI 1992).

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nitrogen gasses." Applicant argues, "it is not apparent wherein 100% oxygen and a mixture of oxygen and nitrogen are disclosed as functionally equivalent for all purposes in connection with etching diamond."

In response the examiner notes that Shiomi etches diamond with 100% O<sub>2</sub> while Brooks etches diamond with a mixture of O<sub>2</sub> and N<sub>2</sub>. This is the basis on which the examiner states that 100% O<sub>2</sub> and an O<sub>2</sub>/N<sub>2</sub> mixture are recognized by those skilled in the art as being functionally equivalent as to their ability to etch diamond.

Applicant suggests that in order to rely upon the functional equivalence of two things those two things must be equivalent in all respects. Applicant notes that Shiomi is concerned with producing heat sinks while Brooks is directed to forming a mask. Applicant reasons, since Shiomi and Brooks are not concerned with solving the same problem, the O<sub>2</sub>/N<sub>2</sub> etchant mixture of Brooks cannot be functionally equivalent to the O<sub>2</sub> etchant of Shiomi. Presumably, applicant's reasoning is based upon the notion that two things cannot be functionally equivalent if they are used for different purposes.

First off, the examiner notes that the function of interest is simply the ability of a plasma gas to etch diamond. The examiner relies on the functional equivalence between O<sub>2</sub> and a mixture of O<sub>2</sub>/N<sub>2</sub> only with respect to their ability to function as plasma etchants for diamond. It is not necessary, nor asserted, that these two things be functionally equivalent in all aspects. The fact that Shiomi makes heat sinks, and Brooks makes masks, does not diminish the fact that diamond can be etched by an O<sub>2</sub> plasma as well as by an O<sub>2</sub>/N<sub>2</sub> plasma.



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Clearly, gases that differ in composition will exhibit different spectra.

Nevertheless, the following statements suggests that applicant's concept of functional equivalency extends even to the plasma emission spectra that are obtained from these systems.

*"It should be noted that as far as the emission spectrum is concerned, a gas containing pure oxygen is not functionally equivalent, repeat not functionally equivalent, to a gas mixture containing oxygen. This should be apparent from Figs. 5 and 6."*

*This predetermined emission spectrum is functionally equivalent in controlling the side surfaces of the protrusion or depression such that they are substantially perpendicular, i.e., have an angle of inclination of at least 78°.*

The examiner cannot comment further on the latter statement because the examiner does not understand what applicant considers the functional equivalent counterpart of the emission spectrum.

Applicant argues, that Shiomi's method results in the etched features having an undesirable trapezoidal cross section and applicant argues the present invention addresses and solves this problem.

Applicant states:

*None of the applied references express any recognition for the problem of tilted side surfaces when etching a protrusion or depression on the surface of a diamond body. This problem confronted and solved by Applicants is not even a blip on the radar screens of the applied references.*

However, as the rejection stated, Shiomi teaches that the angle of the sidewall can be controlled by adding  $\text{CF}_4$  to the etchant. Shiomi teaches that vertical sidewalls can be obtained by adding a very small amount of  $\text{CF}_4$ .

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With respect to the role of N<sub>2</sub>, Applicant's arguments include the following statements:

*Further, neither Brooks et al. nor Shiomi provide any suggestion whatsoever to control the amount of nitrogen to achieve the predetermined emission spectrum (A/B) specified in independent claim 1.*

*The mere use of an oxygen/nitrogen mixture to etch a diamond membrane to form a mask can hardly be considered motivation to go back to Shiomi's method and control the taper of the side surfaces, particularly where there is no mention of that problem in the applied prior art or the relationship of nitrogen in solving that problem.*

The examiner is not compelled by the argument that nitrogen plays a role in controlling the taper of the side surfaces because applicant's specification provides no evidence that the amount of nitrogen controls the taper of the sidewall.

With respect to motivation, applicant argues, "there is no motivation" to combine the references. Applicant also notes "the requisite motivation must be undertaken with a reasonable expectation of successfully achieving a recognized objective."

The examiner notes that express motivation is not required when relying upon functionally equivalency. Additionally, the above rejection noted that the teaching of Nasser-Faili would provide the skilled artisan with a reasonable expectation of success because Nasser-Faili demonstrates the etching of diamond with plasma comprising oxygen, nitrogen and a low fluorine content. Lastly, regarding motivation, it is noted that applicant did not comment on the following asserted basis for obviousness: It would have been obvious to one skilled in the art to etch diamond with plasma comprising O<sub>2</sub> and N<sub>2</sub> and a fluorine-containing compound because Shiomi teaches using either O<sub>2</sub> or

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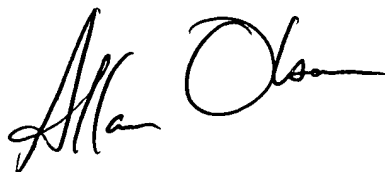
N<sub>2</sub> and "[i]t is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose."<sup>supra</sup>

### **Conclusion**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. The examiner can normally be reached on M, W and F: 1-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on 571-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

A handwritten signature in black ink, appearing to read "Allan Olsen", is positioned to the left of the typed name and title.

Allan Olsen  
Primary Examiner  
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